Oregon
Theodore Kulongoski, Governor

**Department of Environmental Quality**
**Northwest Region Portland Office**
2020 SW 4th Avenue, Suite 400
Portland, OR 97201-4987
(503) 229-5263
FAX (503) 229-6945
TTY (503) 229-5471

August 12, 2009 *Also Sent Via E-mail*

Tom McCue, Environmental Manager
Siltronic Corporation
7200 NW Front Avenue
Portland, OR 97210

**Re: Enhanced In-Situ Bioremediation Performance/Effectiveness Plan**
**Siltronic Corporation**
**Portland, Oregon**
**ECSI No. 183**

Dear Mr. McCue:

The Department of Environmental Quality (DEQ) reviewed the "EIB Performance/Effectiveness Plan, Siltronic Corporation," dated June 30, 2009 (EIB P/E Plan). Maul Foster & Alongi, Inc. (MFA) prepared the EIB P/E Plan on behalf of the Siltronic Corporation (Siltronic). The EIB P/E Plan provides Siltronic's alternative approach for evaluating the performance of enhanced in-situ bioremediation (EIB) being used as a removal action (i.e., source control measure) in the vicinity of the former solvent underground storage tank system (Former UST System).

The EIB P/E Plan has been developed by Siltronic for incorporation into the EIB Performance Monitoring Plan (EIB PMP) currently in preparation. DEQ requested the EIB P/E Plan during a meeting with Siltronic on June 16, 2009 because the angled monitoring well (WS-24-155), a necessary component of the EIB performance monitoring program, has not provided data considered to be representative of contaminated groundwater beneath the Fab 1 building. In an e-mail sent June 17th, DEQ indicated the EIB P/E Plan should include:

- A list of specific water quality parameters and chemical constituents Siltronic considers important for monitoring the performance and effectiveness of EIB upgradient of the Fab 1 building.
- Numerical values and/or data trends for each parameter/constituent to be used to monitor EIB performance and trigger contingency measures.

DEQ also requested the input parameters for the fate and transport model Siltronic is using to simulate EIB performance in the Former UST System area (i.e., the source area) and predict downgradient groundwater concentrations of chlorinated volatile organic compounds (cVOCs), including trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC). DEQ and MFA met on July 23rd to discuss the fate and transport model with the purpose of increasing DEQ's understanding of the modeling approach and facilitate preparation of this letter.

This letter informs Siltronic the EIB P/E Plan does not provide adequate information to support contingency planning and implementation for the EIB PMP. DEQ acknowledges Siltronic's discussions regarding using multiple lines of evidence supported by additional sampling analysis as

being the basis for making decisions. However, the EIB P/E Plan does not lay-out a decision making process for using performance monitoring data to trigger contingencies.

## EIB PERFORMANCE MONITORING PLAN CONTENT

The EIB PMP Siltronic is preparing will present the details of collecting and using groundwater data to: 1) evaluate EIB performance and effectiveness in the source area, and 2) trigger contingency measures. Given the EIB P/E Plan lacks a defined approach for using monitoring data to implement contingencies, DEQ expects the EIB PMP to include the following:

- Sampling and analysis of groundwater in all Group 1 and Group 2 performance monitoring wells (PMWs) consistent with the Revised EIB Work Plan[1] approved for implementation by DEQ (i.e., monthly sampling for the full suite of analyses). Contrary to the approved sampling and analytical program, DEQ understands groundwater monitoring is currently being conducted every other month. Siltronic should resume monthly sampling effective upon receipt of this letter. Revisions to the approved performance monitoring program should be made in writing accompanied by the technical justifications for the changes.
- Collecting representative samples of groundwater from PMW WS-24-155, and absent the ability to collect these samples, abandoning and replacing the installation.
- Using projections of the time for EIB-treated groundwater to migrate beneath Fab 1, increase the sampling frequency to at least monthly at the Group 3 PMWs with the objective of monitoring the arrival and migration of treated groundwater at these installations.
- Planning for reapplication of EIB treatment media within approximately 3 years (i.e., early summer 2012), or sooner if: 1) TCE concentrations rebound to greater than the injection threshold of 11,000 micrograms per liter (ug/L, or parts per billion), or 2) increasing concentrations of cVOCs are observed at Group 3 PMWs. For purposes of #2, two consecutive data points falling on an upward trend-line confirm increasing cVOCs concentrations and will trigger reapplication in the source zone and/or under Fab 1. These criteria are based on the following information:
  - Available contingencies rely on maintaining subsurface conditions favorable to reductive dechlorination through additional EIB applications. Vender estimates for reapplication range between 3 and 5 years. The Siltronic model applies favorable EIB conditions near the source area (i.e., Zone 1) beyond 5 years (i.e., from 2 years to greater than 12 years from injection).
  - The remedial action objective for the Former UST System vicinity is to reduce TCE concentrations to less than 11,000 ug/L throughout the source area.
  - Siltronic's fate and transport model predicts cVOC concentrations in Group 3 PMWs should not increase.

In addition to the expectations for the EIB PMP listed above, DEQ has comments regarding the REMChlor model being used to assess EIB performance at the site.

[1] Maul Foster Alongi, Inc., 2008, "Revised Enhanced In-Situ Bioremediation Source Control Work Plan, Siltronic Corporation," October 20, a work plan prepared for Siltronic Corporation .
[2] Siltronic uses 500,000 micrograms/liter (ug/L), one-third of which is 166,000 ug/L. The historic average

## REMCHLOR MODELING

### General Comments

According to Siltronic, the REMChlor simulation is geared toward predicting cVOC remediation in the vicinity of the Former UST System and concentrations along the axis of the plume downgradient of the source area. DEQ's review determined the model is sensitive to certain input parameters including, but not necessarily limited to; Darcy velocity, source concentration, source degradation path, and contaminant degradation rates. Small changes made to these variables result in very different cVOC concentration versus distance trends compared to the Siltronic version of the model. For example, keeping all other input parameters fixed and reducing the Darcy velocity by half (or source concentration by a third[2]) causes:

- Additional build-up of daughter products within the first 6 meters of the model domain (i.e., Zone 1 and Zone 2);
- Persistence of the source area beyond 12 years, the maximum length of time for Siltronic's model output; and
- An increase in the time needed to reduce downgradient cVOC concentrations to less than Joint Source Control Strategy criteria.

Models such as REMChlor allow ranges of site scenarios to be simulated relatively rapidly using purpose-specific versions of the model. Based on DEQ's review, the current model assesses TCE degradation in the source area, daughter product concentrations under Fab 1, and cVOC concentrations at Group 3 PMWs *under conditions that simulate rapid source depletion* (italics added for emphasis). Under the current model input parameters the persistence of the cVOC source and downgradient plume is underestimated. As such, the length of time needed to remediate the source/plume is also underestimated.

DEQ expects Siltronic to develop alternate versions of the model with the objective of assessing source longevity and downgradient cVOC concentrations under reasonably conservative site specific assumptions. As groundwater data comes in from PMWs, Siltronic will update each version and let the data ultimately determine which one best represents fate and transport conditions operating at the site.

### Specific Comments

With the objective of developing alternative versions of the model, Siltronic should adjust input parameters in the current working version. DEQ's comments regarding input parameters are provided below.

- **Source Concentration** – DEQ considers the value of 500,000 ug/l used for this term to overestimate mass flux out of the source area and into the groundwater plume. As such, the model likely underestimates the persistence of the source/plume. More reasonable estimates of

[2] Siltronic uses 500,000 micrograms/liter (ug/L), one-third of which is 166,000 ug/L. The historic average concentration of TCE at monitoring well WS-13-69 is approximately 160,000 ug/L.

the source concentration should rely on data from the source area, such as the historic average TCE concentration estimated for WS-13-69, or the average pre-injection TCE concentration for Group 1 PMWs.

- **Darcy Velocity and Retardation Factor** –the value of 20 meters/year used in the model is based on an average pore water velocity of 0.625 feet/day. Coupled with the assumed source concentration, this value adds to overestimating mass flux out of the source area because pore water velocities are likely lower in the source area. Further downgradient, geologic observations and site data indicate pore water velocities increase to 1-2 feet/day (i.e., Darcy velocities of 33-66 meters/year). Besides using average pore water velocity, the model utilizes an average retardation factor of 1.6 for all contaminants. The cVOC with lowest screening value in groundwater migrating to the river is VC, which has a retardation factor of 1.1. As such, in the vicinity of Group 3 wells, the effective migration rate of dissolved VC is simulated by Siltronic using an average contaminant migration velocity of 0.4 feet/day ([0.625 feet/day]/1.6), when it may be closer to 0.9-1.8 feet/day ([1-2 feet/day]/1.1). DEQ acknowledges REMChlor applies one pore water velocity and retardation value over the model domain to simulate contaminant fate and transport. However, a reasonably conservative simulation could be based on using VC fate and transport parameters (i.e., retardation of 1.1 rather than 1.6, and a pore water velocity selected within the upper range for the site [1-2 feet/day]).
- **Source mass** – the EIB P/E Plan indicates the 4000 kilogram value is a conservative estimate as it is approximately four times the source mass estimated using geostatistical methods. DEQ considers this value to carry with it a high degree of uncertainty as it is based on modeling cis-1,2-DCE production. However, relative to source concentration and input parameters influencing contaminant degradation and transport, the model is less sensitive to this variable.
- **Gamma (Γ)** – this term is used to describe the relationship between source mass and source concentration with time, and is useful in predicting source/plume persistence. A value of 0.725 was used in the Siltronic model. Although not specifically discussed in the EIB P/E Plan, DEQ understands values less than one are typically applied to situations where:
  - Contaminant is distributed within more permeable geologic material; and
  - Source mass decreases at a greater rate than concentrations, resulting in relatively rapid source depletion and less concentration tailing over time.

  The geology beneath the Former UST System area is predominantly unconsolidated intermixed silt, sandy silt, and silty sand, with lesser amounts of fine to medium sand. Overall the sediments appear to be fine-grained in nature. Given this information, the gamma term selected for the model may predict higher rates of mass removal and further contribute to predictions of rapid source depletion and underestimates of source/plume persistence. Given geologic observations in the source area, DEQ recommends running a sensitivity analysis of this term using a range of values more representative of fine-grained material. The sensitivity analysis will provide values for use in the alternative simulations.
- **Degradation Rates** – DEQ understands from the July 23rd meeting, it is desirable to use representative "biodegradation rate constants" in REMChlor to simulate fate and transport of cVOCs. DEQ further understands the degradation rates used in the Siltronic model are based on

either: 1) cVOC concentration and time trends plotted at an individual PMW (Zone 1), or 2) cVOC concentration and distance trends assessed between PMWs located at different points along the plume axis (zones 2 and 3). During the meeting DEQ concurred with the assumptions and methods used to select degradation rates for zones 1 and 2 where, due to EIB applications, biodegradation is the dominant process. However, there is increased uncertainty using this assumption in Zone 3 where declines in cVOC concentrations reflect the combined influence of dispersion, sorption, and biodegradation. DEQ recommends the cVOC degradation rates for Zone 3 be checked using an alternative method, such as calibrating a groundwater fate and transport model (e.g., Bioscreen or BioChlor) to data along the axis of the cVOC plume through iterative adjustments to the biodegradation rate constant.

**NEXT STEPS**

Within 14 business days of receiving this letter, Siltronic should submit an EIB PMP that incorporates DEQ's comments regarding performance monitoring data collection and the criteria for contingency planning and implementation. In addition, within 30 days of receipt of this letter, Siltronic should provide list(s) of input parameters for alternative REMChlor simulations to further assess source/plume longevity and downgradient cVOC concentrations under reasonably conservative site specific assumptions.

Please call me at (503) 229-5543 if you have questions regarding this letter.

Sincerely,

Dana Bayuk, Project Manager
NWR Cleanup Section

Cc: Alan Gladstone, Davis Rothwell Earle & Xochihua, P.C.
James Peale, MFA
Eric Bakkom, MFA
Bob Wyatt, NW Natural
Patty Dost, Schwabe Williamson & Wyatt
John Edwards, Anchor Environmental, LLC
Carl Stivers, Anchor Environmental, LLC
Rob Ede, Hahn and Associates, Inc.
Kristine Koch, EPA
Sean Sheldrake, EPA
Jim Anderson, DEQ/PHS
Tom Gainer, DEQ/PHS
Henning Larsen, DEQ/SRS
Matt McClincy, DEQ/PHS
ECSI No. 183 File
ECSI No. 84 File